Assessment of EIFOV Based on Natural Edges for Satellite Images

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Problem

Satellite imagery has been widely used in remote sensing activities
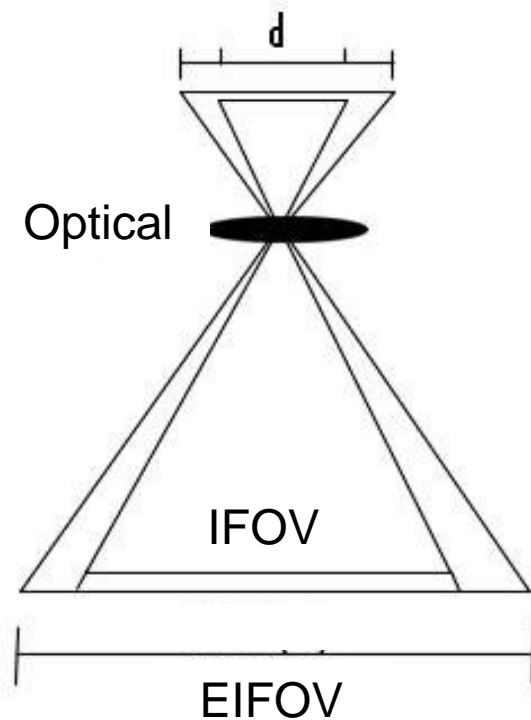
Blurring Effect in Images

Original scene

sensor

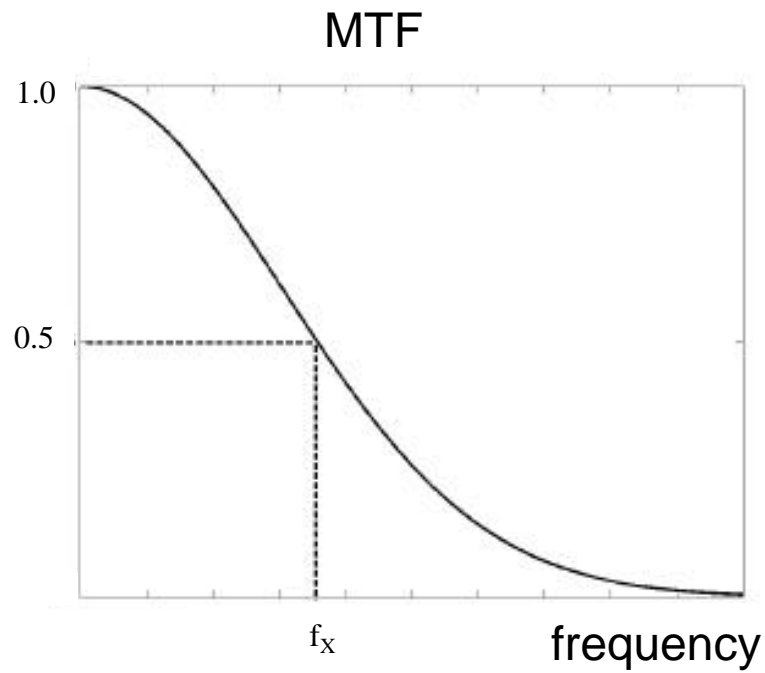Generated image

→ Effective resolution is worse than nominal resolution

IFOV = Instantaneous Field of View
EIFOV = Effective Instantaneous Field of View

$$EIFOV = 1.5 \times IFOV$$

To assess the blurring effect , the parameter EIFOV can be used

d

Optical

IFOV

EIFOV

MTF

$$\text{EIFOV} = \frac{1}{2f_x} \longrightarrow \text{EIFOV} = 2.66\,\sigma$$

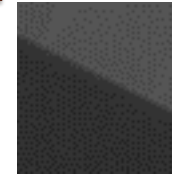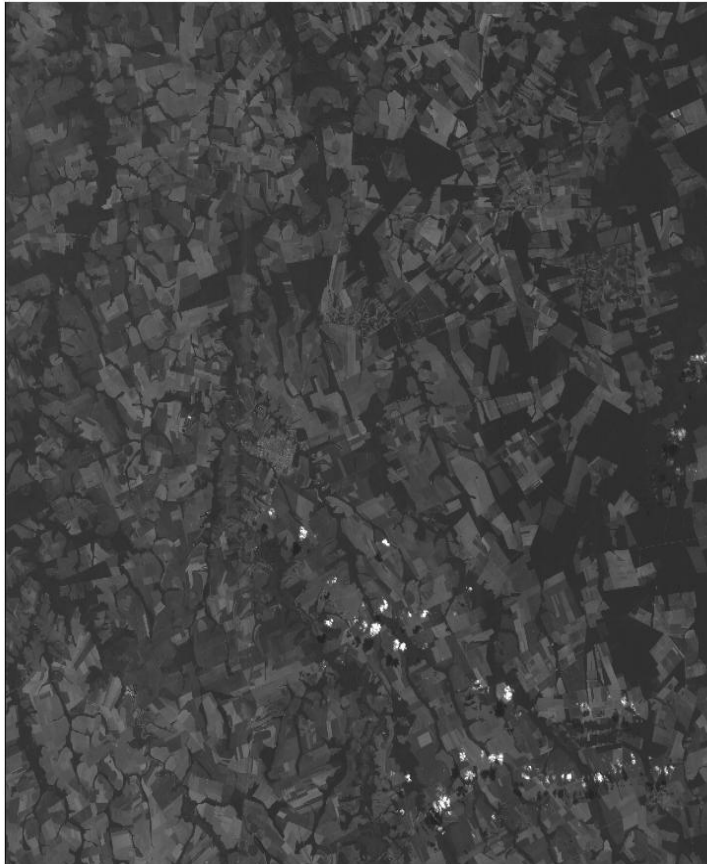σ = standard deviation of MTF , modeled as a Gaussian function

Step Edge Method

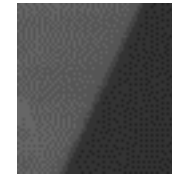Objective: estimative EIFOV based on a Step Edge Method using natural scenes

Consists of estimating EIFOV using a set of subimages of natural edges (with different directions) extracted from the scene

Ideal Step Edge → Imaging System → Spread Step Edge
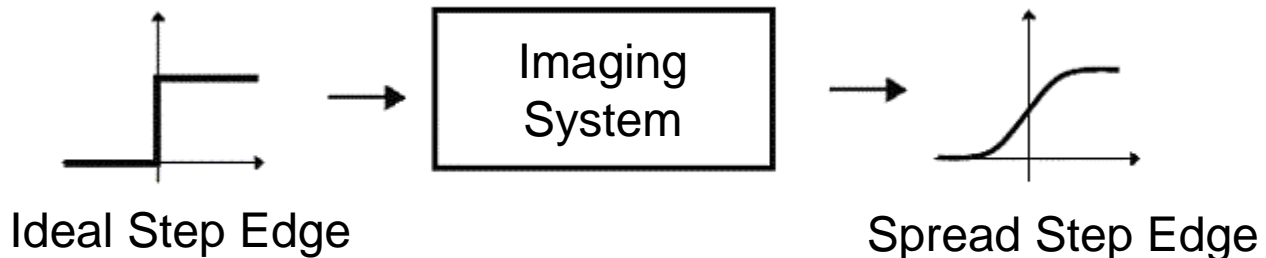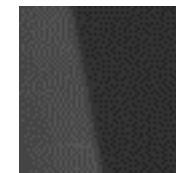
Step Edge Method Description

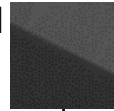Subimage1

Subimage 2

Subimage 3

.
.
.

Subimage N

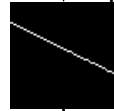Image of Sorriso-MT, Brazil
CBERS-2, CCD, orbit 166, point 114, Band 2
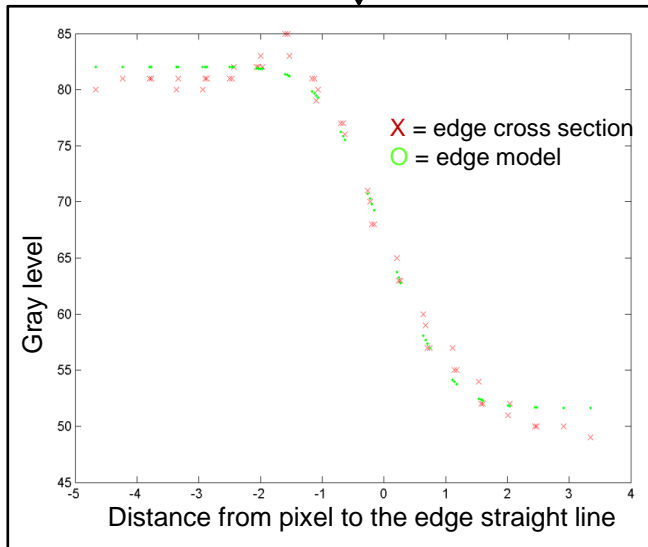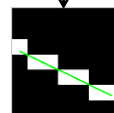Data of acquisition: July, 15, 2006

Subimage 1

Edge Detection

Centering detected edge

Edge linear fitting

$$\sigma_1 \quad \sigma_2 \quad \sigma_3 \quad \ldots \sigma_N$$
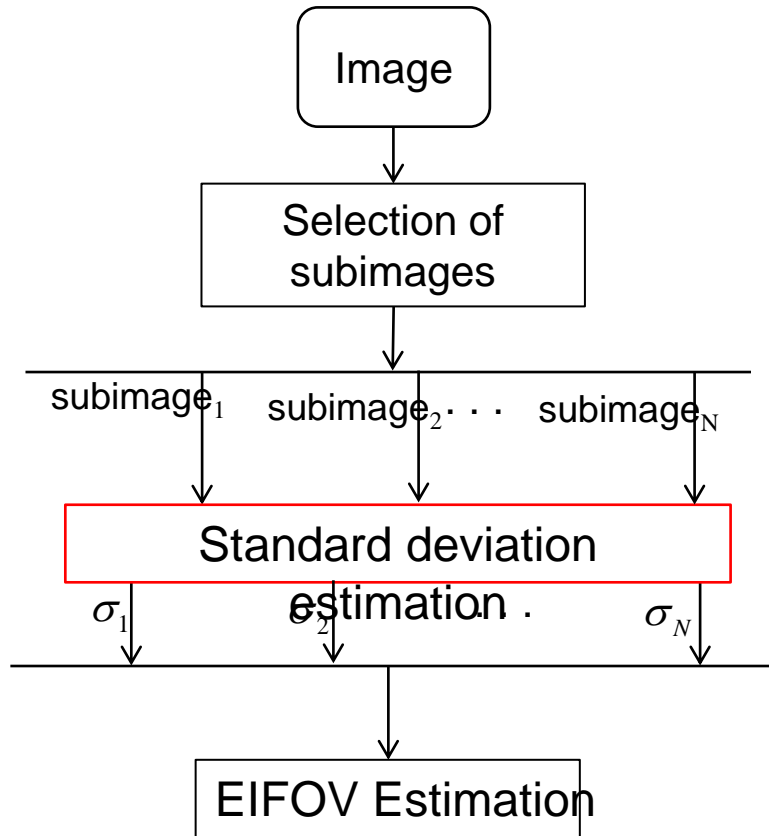
Ellipse fitting

$\sigma_x \rightarrow$ standard deviation in across-track
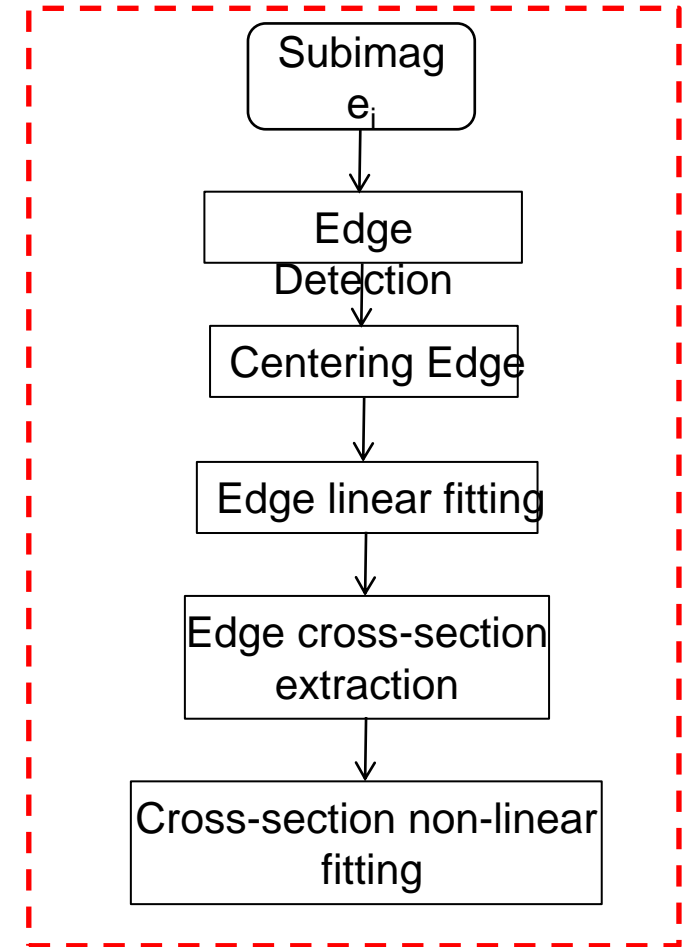
$\sigma_y \rightarrow$ standard deviation in along-track

$$EIFOV_x = 2.66\sigma_x$$

$$EIFOV_y = 2.66\sigma_y$$

X = edge cross section
O = edge model

Gray level

Distance from pixel to the edge straight line

σ_1 standard deviation

In short:

Image → Selection of subimages

subimage$_1$ subimage$_2$ · · ·   subimage$_N$

Standard deviation estimation

σ_1 σ_2 σ_N

EIFOV Estimation

Standard Deviation Estimation Block:

Subimage$_i$ → Edge Detection → Centering Edge → Edge linear fitting → Edge cross-section extraction → Cross-section non-linear fitting
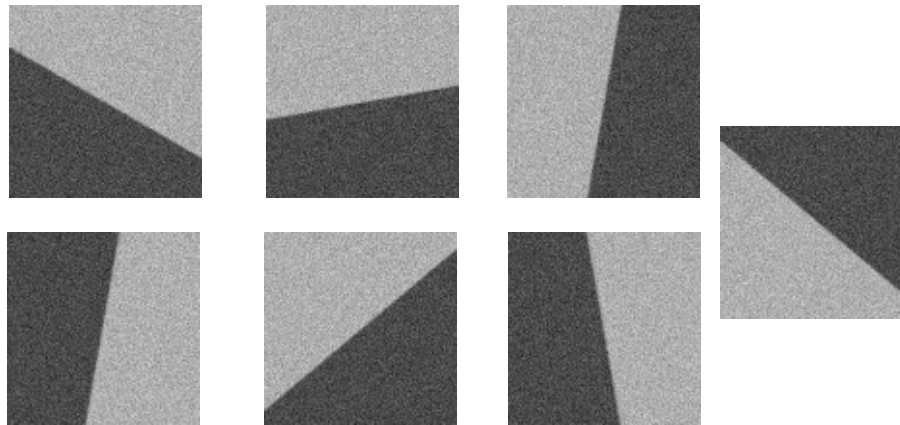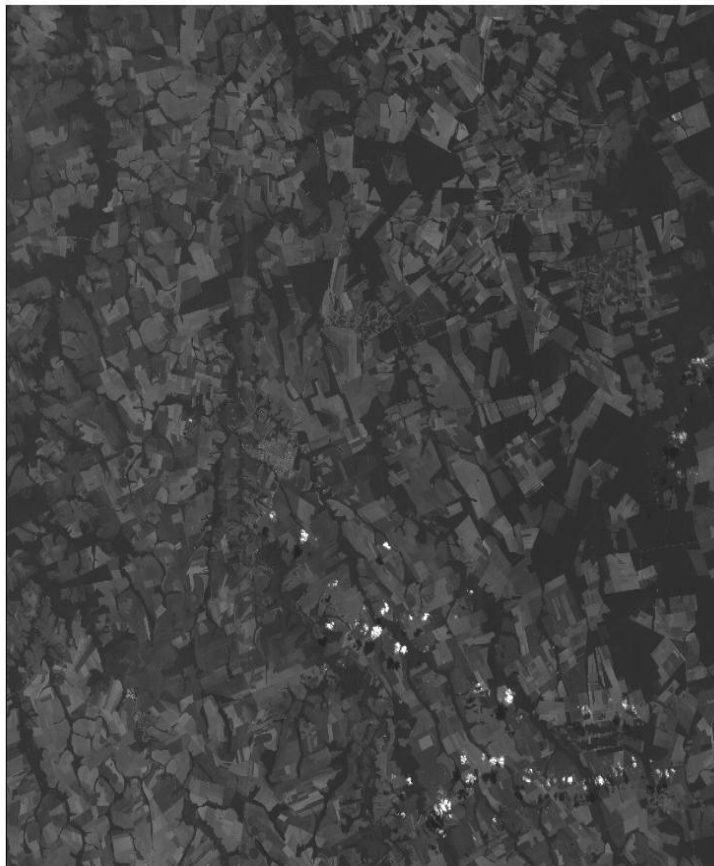
Experiments

Some of simulated images:

Total : 36 simulated images

Simulated images, SNR 10 (SD=standard deviation)		
Direction	Simulated SD	Estimated SD
x	0.45	0.44
y	0.54	0.61

Some of selected subimages:
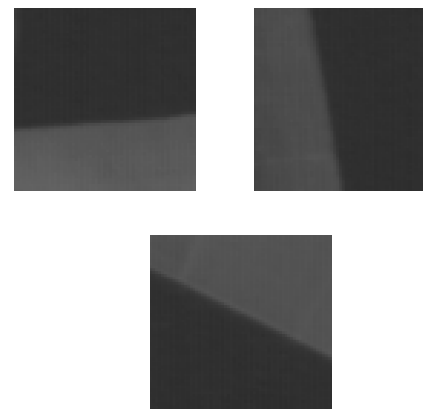
Sorriso ,CBERS 2,CCD, Band 2, Data: July,08,2008		
Direction	Expected EIFOV (m)	Estimated EIFOV(m)
Across-track	30	42.56
Along-track	30	52.99

Some of selected subimages:
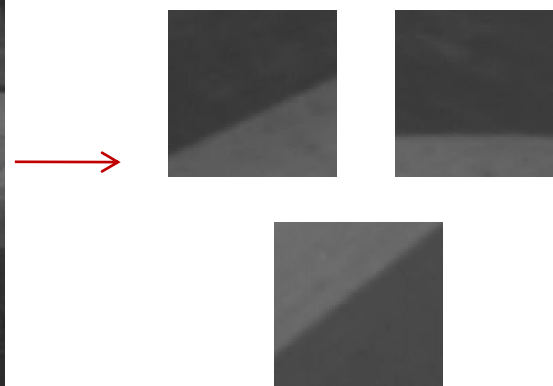
Chapada dos Guimarães,CBERS 2B, HRC, Band 1, Data: August,08,2008		
Direction	Expected EIFOV (m)	Estimated EIFOV (m)
Across-track	4.05	8.99
Along-track	4.05	11.67

Some of selected subimages:
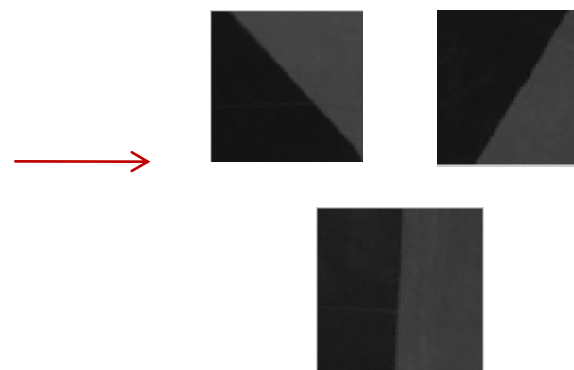
Eduardo Magalhães, Landsat 5, TM, Band 3, Data: September,29,2009		
Direction	Expected EIFOV (m)	Estimated EIFOV (m)
Across-track	45	47.05
Along-track	45	45.59

Conclusions

◦ Test the method using more images:

- Simulated images with others SNR values
- Images of other sensors
- Others images of the same sensors

◦ Develop a method to select automatically subimages

Acknowledgements

Thank you!

Questions?

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